

UNITED STATES DEPARTMENT OF

COMMERCE

John T. Connor, Secretary

Washington, D.C.

Environmental Science
Services Administration

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(NASA-News-Release-ES-66-14) SECOND ESSA
SATELLITE LAUNCHING SCHEDULED 25 FEBRUARY
(NASA) 21 p

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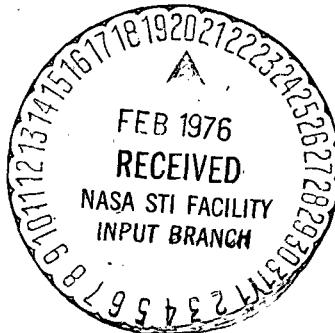
ES 66-14

For A.M. release
February 24, 1966

SECOND ESSA SATELLITE LAUNCHING
SCHEDULED FEBRUARY 25

CONTENTS

	<u>Page</u>
GENERAL RELEASE	1-3
ILLUSTRATIONS	4-5
TOS SYSTEM - A SUMMARY	6-8
ESSA B - TECHNICAL DATA SUMMARY	9-10
ESSA B SPACECRAFT	11
TELEVISION CAMERAS	11
PICTURE RECEPTION	11
DATA ANALYSIS	12
ORBIT	12
FLIGHT PLAN	12-13
FLIGHT EVENTS (TABLE)	14
STABILIZATION AND CONTROL SUBSYSTEMS	15-16
DELTA LAUNCH VEHICLE	17-18
PROJECT MANAGEMENT	19
WEATHER SATELLITE RECORD	20



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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**Environmental Science
Services Administration**

Telephone (301) 496-8193

ES 66 - 14

SECOND ESSA SATELLITE LAUNCHING
SCHEDULED FEBRUARY 25

The second ESSA weather satellite -- carrying cameras that continually take cloud pictures and send them to ground stations around the world -- will be launched no earlier than February 25, the Environmental Science Services Administration (ESSA) of the U. S. Department of Commerce announced today.

The National Aeronautics and Space Administration will launch the spacecraft for ESSA from Cape Kennedy, Fla. The planned orbit will be circular and near polar, approximately 865 statute miles above the earth.

If the launch is successful, the satellite will be named ESSA II (Environmental Survey Satellite). ESSA I, the first spacecraft in the TIROS Operational Satellite (TOS) system, was orbited on February 3. With the launching of the second ESSA satellite, the TOS system will be in full operation.

As the new satellite circles the globe, its two cameras -- called Automatic Picture Transmission (APT) camera systems -- will be photographing clouds beneath the spacecraft and transmitting the pictures immediately to simple receiving stations on the ground. The APT camera system developed by NASA was tested successfully on TIROS VIII and Nimbus I.

- more -



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WO 3-6925

Equipment capable of receiving the APT pictures can be set up anywhere in the world. At the present time, agencies of the United States government are operating approximately 50 such sets in various parts of the world, and foreign countries have about 30. In addition, several private groups in the United States and abroad are equipped to receive the satellite pictures.

The satellite will come within the 2100-mile picture-reception range of any station on two or three orbits a day. Two or three pictures, each covering four million square miles, can be received on each of these orbits. Because the APT system does not store photographs after the transmission period, the ground stations will receive only those "local" pictures transmitted while the satellite is within receiving range.

The APT photographs will be a valuable new tool for weather forecasters in many lands, providing timely information on existing weather conditions over a large area around their stations. The information can be used to improve local weather forecasts, to issue warnings of severe weather, and to select the safest routes for aircraft in flight and ships at sea.

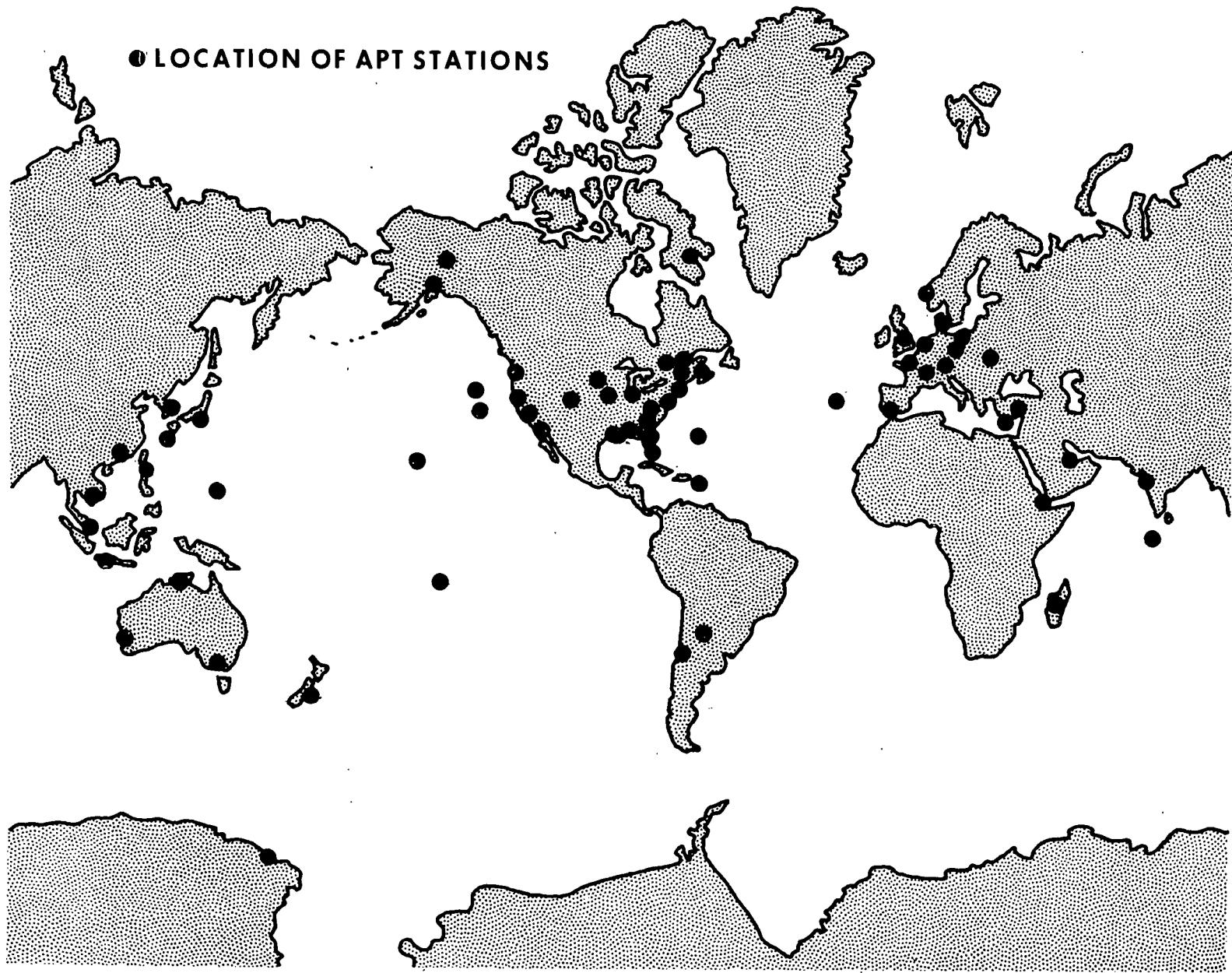
The TOS system, the first operational weather satellite system in the world, is financed by the Environmental Science Services Administration and is managed and operated by ESSA's National Environmental Satellite Center. The system is designed to provide both remote and local cloud cover pictures at least once every day on a global scale.

ESSA I, which inaugurated the TOS system, takes pictures of cloud cover over the entire earth and stores them for readout by the Command and Data Acquisition Stations near Fairbanks, Alaska, and Wallops Station, Virginia. The second ESSA satellite will add the local readout feature, bringing the TOS system into full operation. Thereafter, launches will be scheduled as needed to ensure that one spacecraft with picture-storage capability and one with automatic-picture-transmission capability are operating at all times.

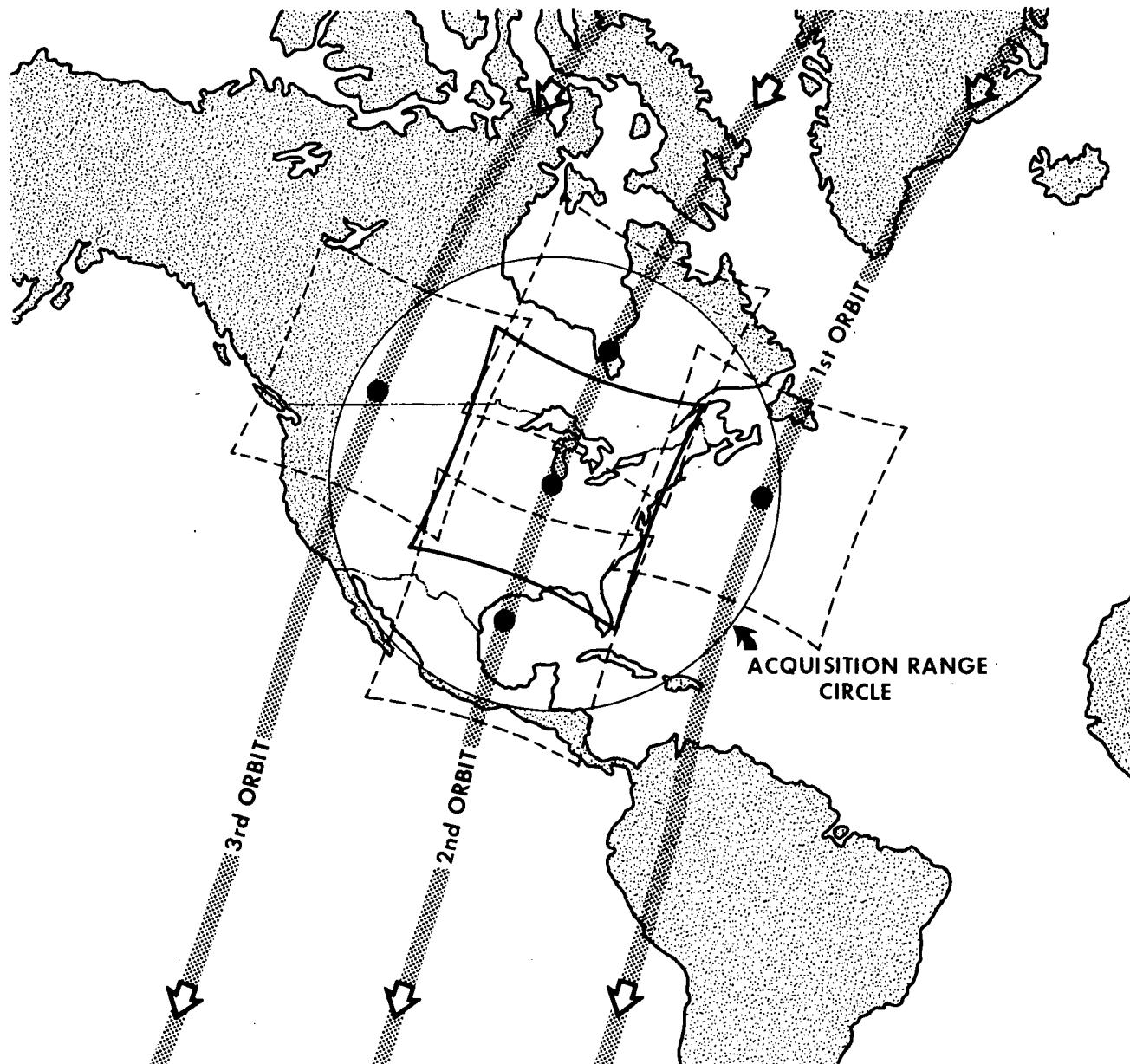
The new ESSA spacecraft, like ESSA I and others planned for the TOS system, is a cartwheel satellite of the TIROS type. As it rolls along in orbit, each of the two cameras on its rim will point directly toward the earth once every revolution. In its near-polar, sun-synchronous orbit, the satellite will view weather all over the sunlit portions of the world once every day, photographing a given area at the same local time each day.

(END OF PRESS RELEASE; BACKGROUND DATA FOLLOWS)

● LOCATION OF APT STATIONS



SATELLITE TRAVELS FROM NORTH TO SOUTH ON DAYLIGHT SIDE OF EARTH



A PATTERN OF PICTURE RECEPTION AT A TYPICAL APT STATION. Receiver at Chicago will acquire pictures covering the areas indicated by solid and broken lines, plus parts of other pictures transmitted while the satellite is within acquisition range.

TIROS OPERATIONAL SATELLITE (TOS) SYSTEM

- A Summary -

The TIROS Operational Satellite (TOS) system, designed to meet national meteorological requirements, will begin full operation with the launching of the second ESSA satellite.

The TOS system is the first component of the National Operational Meteorological Satellite System (NOMSS) authorized by Congress in 1961. Plans for the TOS system were agreed upon in 1964 by the U. S. Department of Commerce, the National Aeronautics and Space Administration, and the Department of Defense.

The TOS system is financed by the Environmental Science Services Administration (ESSA) of the Department of Commerce and is managed and operated by ESSA's National Environmental Satellite Center. The National Aeronautics and Space Administration is responsible for procurement, launch, and initial check-out of the spacecraft in orbit. After NASA has determined that an orbiting satellite is ready for operational use, the National Environmental Satellite Center assumes control of the spacecraft and supporting ground systems. The Satellite Center also processes the data and furnishes it to the ESSA Weather Bureau, other U. S. agencies including the Department of Defense, and foreign governments for operational use in preparing weather analyses and forecasts.

An operational weather satellite system must provide global data on a daily basis without interruption. The TOS system will provide regular and continuous cloud picture coverage of the entire sunlit portion of the earth at least once a day. Certain infrared observations of value to meteorology also will be made by the TOS system.

The Weather Bureau has made operational use of meteorological data received from the first ten TIROS satellites. Nine of these were NASA research and development spacecraft, and one was purchased by ESSA. The operational value of data from the first eight was limited due to incomplete and irregular coverage. These satellites could view only 20 percent of the earth each day, because they were conventional TIROS spacecraft with cameras mounted in the base and were spin-stabilized in orbits inclined either 48 or 58 degrees to the Equator.

TIROS IX, which was launched January 22, 1965, had the same shape as the earlier TIROS spacecraft, but was redesigned to a "cartwheel" configuration. In the TIROS IX and ESSA I cartwheel satellites, the cameras point outward from the rim of the satellite (at a 26-degree angle) rather than from the bottom. After being injected into orbit, a cartwheel satellite is turned so that its spin axis is perpendicular to the orbital plane. In this position, the satellite rolls along in orbit on its side like a wheel, and the cameras take pictures only when pointing at the earth. TIROS IX was placed in a near-polar, sun-synchronous orbit, which permitted daily picture coverage of the entire globe except for those areas in polar darkness.

TIROS X, the first ESSA-funded weather satellite, was launched on July 2, 1965, to provide coverage during the hurricane season. This satellite was a conventional TIROS spacecraft, but it was launched into a near-polar, sun-synchronous orbit to permit more comprehensive picture coverage than that provided by the first eight TIROS satellites.

TIROS VII, VIII, IX, and X are still in operation.

The spacecraft used in the TOS system are cartwheel satellites, similar in many respects to TIROS IX. TOS system satellites are designated ESSA - for Environmental Survey Satellite - and each is assigned a Roman numeral (I, II, III and so on consecutively) after it has been successfully launched.

With the TOS system in full operation, two ESSA satellites - one with automatic-picture-transmission capability and one with picture-storage capability - will be in orbit at all times to provide both worldwide and local cloud cover pictures at least once a day.

The first satellite in the TOS system was launched on February 3, 1966. It is identical to TIROS IX, containing two cameras with picture-storage capability, and was placed in a near-polar, sun-synchronous orbit with an apogee of 521 statute (452 nautical) miles and a perigee of 432 statute (375 nautical) miles.

The second satellite in the TOS system will contain two Automatic Picture Transmission camera systems (see page 11).

This satellite, and succeeding spacecraft in the TOS system, will be launched into near-polar orbits 865 statute (750 nautical) miles above the earth. The orbits will be sun-synchronous, so that the cameras photograph a given latitude at the same sun time on every orbit. At an altitude of 865 statute miles, the orbital period of the satellites will be approximately 113 minutes. The satellites will be similar to TIROS IX, except that the cameras will be mounted to point directly outward through the rim instead of being tilted at a 26-degree angle. The higher orbital altitude allows each camera to point straight downward and still leave no gaps at the Equator between pictures taken on successive orbits.

TOS system spacecraft destined for 865-mile-high orbits will be launched by means of improved Thrust-Augmented Thor-Delta rockets. NASA is constructing Delta launch facilities at the Western Test Range at Point Mugu, California, which eventually will be used for TOS launches. Pending completion of these facilities, launches will be made from the Eastern Test Range at Cape Kennedy, Florida.

When the ESSA I satellite ceases to be useful for meteorological operations, it will be succeeded by spacecraft carrying two cameras of the Advanced Vidicon Camera System (AVCS) type developed by NASA for the Nimbus weather satellite. This camera unit works in a manner similar to earlier TIROS cameras, storing data on magnetic tape for rapid transmission to one of ESSA's two primary Command and Data Acquisition (CDA) stations located at

Gilmore Creek, near Fairbanks, Alaska, and at Wallops Station, Virginia. The AVCS pictures will have 800 scan lines and cover an area about 2,000 statute (1,736 nautical) miles square. A single camera can provide daily global coverage. However, the AVCS satellites will carry two camera systems to provide redundancy and thus increase the operational lifetime of the spacecraft. The AVCS spacecraft probably will be timed to obtain cloud pictures in midafternoon.

Acquisition and Analysis of Stored Data. Stored data are received from the ESSA satellites at the Command and Data Acquisition (CDA) stations at Gilmore Creek, Alaska, and Wallops Station, Virginia. Meteorological data are recorded on magnetic tape and immediately retransmitted to the National Environmental Satellite Center at Suitland, Maryland. Here, the picture signals are projected on special TV screens (kinescopes) and photographed by 35-mm. cameras. A latitude and longitude grid prepared by computer is electronically combined with the picture signal to provide location information.

Meteorologists use the gridded photographs to produce cloud-cover maps, called nephanalyses. The National Meteorological Center of the Weather Bureau then integrates the cloud maps with worldwide data obtained by conventional weather-observing methods for use in daily weather analysis and forecasting. The satellite analyses are also relayed to field stations in the United States and to other countries throughout the world.

NOTE: The TOS system will be modified as improved features are developed and tested. Thus, the system details described above are subject to change.

ESSA B

TECHNICAL DATA SUMMARY

Spacecraft Cylindrical, 18-sided polygon, 22 inches high and 42 inches in diameter, weighing 290 pounds.

Mission Objectives Add Automatic Picture Transmission capability to the TIROS Operational Satellite System.

Provide daily coverage of local weather systems for weather stations around the world equipped with APT receivers.

Launch Information:

Vehicle Three-stage, Thrust-Augmented Improved Delta.

Launch Pad Complex 17, Pad B, Eastern Test Range, Cape Kennedy, Florida.

Date. No earlier than February 25, 1966.

Time 8:58 a.m. EST.

Orbital Elements:

Inclination Near polar and sun synchronous, 78.6 degrees retrograde to the Equator.

Period 113.5 minutes.

Orbit Circular, approximately 865 statute (750 nautical) miles high.

Velocity Approximately 16,300 miles per hour.

Cameras Two 1-inch Automatic Picture Transmission vidicons which take more than 140 two-thousand-statute-mile-square pictures daily with a resolution of about two miles at picture center.

Power System	9,100 solar cells (N on P) which convert sun energy to electrical energy to keep 63 nickel-cadmium batteries charged.
Tracking	Fifteen stations of the worldwide Space Tracking and Data Acquisition Network (STADAN) operated by the Goddard Space Flight Center.
Command and Data Acquisition Stations	Wallops Station, Virginia Gilmore Creek, Alaska
APT Acquisition Stations	United States, 50 stations. Other nations, 30 stations.
Program Management	National Environmental Satellite Center, Environmental Science Services Administration, Department of Commerce
Spacecraft & Launch Vehicle Management	NASA Office of Space Science and Applications, Goddard Space Flight Center.
Launch Operations	Kennedy Space Center
Major Contractors:	
Delta Vehicle	Douglas Aircraft Company
ESSA Spacecraft	Radio Corp. of America

THE ESSA B SPACECRAFT

The second ESSA satellite, like its predecessors in the TIROS and ESSA series, is a hatbox-shaped structure. The spacecraft is an 18-sided polygon which weighs 290 pounds, stands 22 inches high, and measures 42 inches in diameter.

Mounted on the top and sides of the satellite structure are 9,100 solar cells. Protruding from the top of the spacecraft is an 18-inch receiving antenna which receives commands from the two Command and Data Acquisition stations. Four 22-inch transmitting whip antennas, which extend from the bottom or baseplate of the satellite, transmit television pictures, as well as telemetry information on the spacecraft temperature, pressure, battery charge levels, spin rate, and other "housekeeping" data.

TELEVISION CAMERAS

The camera subsystems are two identical 1-inch Automatic Picture Transmission (APT) cameras, which take cloud photographs and send them immediately to simple receiving stations on the ground. Similar cameras were tested on TIROS VIII and Nimbus I.

Each of the two cameras has a wide-angle (90-degree) lens. The two cameras are mounted 180 degrees apart on the side of the spacecraft and perpendicular to the spin axis, so they point directly downward once every revolution (every 5.5 seconds). An onboard camera-triggering system programs the cameras to take pictures only when facing the earth.

The APT system automatically takes and transmits a picture every 352 seconds while the satellite is in daylight. The picture is retained on a photo-sensitive layer of the vidicon tube's face during the 200-second transmission period. Images recorded by the camera are scanned line by line and sent to earth by a transistorized FM transmitter.

Each APT picture has 800 scan lines and covers an area on the earth about 2000 statute (1736 nautical) miles on a side when taken from an 865-statute-mile altitude. Picture resolution is about 2 statute (1.5 nautical) miles per scan line directly below the camera and about 5.2 statute (4.5 nautical) miles at the picture edge.

The satellite has two APT systems either of which, operating independently, can provide the required global coverage. This dual system will ensure a longer operational lifetime for the spacecraft.

PICTURE RECEPTION

Specially designed APT receiving equipment may be installed anywhere it is needed. A properly equipped ground station can receive pictures when the satellite is within a radius of about 2100 statute (1800 nautical) miles. Every day such a station can acquire two or three pictures per orbit on each

of one to three orbits. The number of daily orbits on which the satellite comes within receiving range depends on the latitude of the station, being greater near the poles and lower near the Equator.

At the ground stations, APT pictures can be recorded on both magnetic tape and facsimile equipment. The magnetic tape recording can be used to make multiple copies or to transmit the pictures to other stations equipped with facsimile receivers.

The National Environmental Satellite Center sends alert messages to stations throughout the world so they can determine the times when the satellite will be within range of their receivers.

DATA ANALYSIS

After APT pictures are received at a ground station, they must be gridded with latitude and longitude lines to provide location information. For this purpose, the National Environmental Satellite Center has sent an APT Users Guide and a set of latitude-longitude grids to every known APT station.

The APT pictures provide meteorologists with immediate, timely information on cloud and weather conditions over a large area around the receiving station. This information can be used to improve local forecasts, to brief pilots flying in the area, and to issue warnings of severe weather conditions.

THE ORBIT

The combination of the cartwheel configuration and the near-polar, sun-synchronous orbit permits complete coverage of the earth's weather.

In a sun-synchronous orbit, the precession (eastward drift) of the satellite is about one degree daily, at the same rate and direction as the earth moves around the sun, so the satellite photographs each area of the earth at the same local sun time every day.

THE FLIGHT PLAN

The launch vehicle for this mission is the NASA-developed, three-stage, Thrust-Augmented Improved Delta, which can put three times more weight into orbit than earlier Deltas.

If the launch is successful, it will be the 34th time Delta has achieved orbit in 37 attempts for the Delta family of boosters. This will also be the fourth attempt to place a satellite in near-polar orbit from Cape Kennedy by NASA.

The flight path is very similar to those flown by TIROS IX, X, and ESSA I.

The launch vehicle will perform three precise "dog-leg" or turning maneuvers to inject the satellite into a sun-synchronous, near-polar, circular orbit. Injection will occur about 18 minutes after liftoff when the spacecraft is about 700 miles west of Quito, Ecuador.

The spacecraft will be placed into an orbit which has an altitude of 863 miles, a period of 113 minutes, and inclination to the Equator of 79 degrees (retrograde).

Liftoff is scheduled for 8:58 a.m. EST from Pad 17B. The launch window is 8:58--9:33 a.m. EST.

Flight Path

Delta will be launched on an initial azimuth of 115 degrees True. Two seconds after liftoff, the three-stage rocket begins to roll and seven seconds later the vehicle is on a new heading of 140 degrees True.

About four seconds after liftoff, Delta begins to pitch downward gradually until the launch vehicle's nose is at a 45-degree angle to the earth about 90 seconds after launch.

The first major yaw command, which turns the vehicle 33 degrees to the right, occurs during first-stage burning of the Thor, from T plus 80 to T plus 100 seconds.

Following second-stage ignition at T plus 155 seconds, another yaw command, from T plus 160 to T plus 173 seconds, turns the vehicle $2\frac{1}{2}$ degrees to the right. The Delta is also pitched down six degrees from T plus 175 to T plus 300 seconds.

Delta's final dog-leg or yaw maneuver occurs during the nine-minute coast period between second-stage burnout and third-stage ignition. A yaw command turns the vehicle 15 degrees to the right between 700 and 800 seconds after liftoff, and the vehicle is also pitched down 50 degrees from T plus 600 to T plus 700 seconds.

Thrust-Augmented Improved Delta Flight Events (nominal) For OT-2 Mission

<u>EVENT</u>	<u>TIME</u>	<u>ALTITUDE</u> (STATUTE MILES)	<u>SURFACE RANGE</u> (STATUTE MILES)	<u>VELOCITY</u> MILES PER HOUR
Strap-on Solids Burnout	43 sec.	7.2	2	1,705
Strap-on Solids Separation	70 sec.	17	8	2,386
Thor burnout	2 min. 31 sec.	85	71	7,977
2nd. stage ignition	2 min. 35 sec.	97	81	7,909
Shroud separation	2 min. 39 sec.	98	83	7,909
2nd. stage burnout	9 min. 4 sec.	551	863	12,682
3rd. stage ignition	18 min. 5 sec.	863	2,302	11,182
3rd. stage burnout	18 min. 28 sec.	863	2,403	16,023

STABILIZATION AND CONTROL SUBSYSTEMS

Two dynamic control (DYCON) units in TOS control the satellite's spin rate, camera timing, and the magnetic attitude coil currents which steer the satellite to the cartwheel attitude and maintain it in that position.

Shortly before the burned-out second stage of Delta separates from the third stage, the entire vehicle spins up to approximately 125 r.p.m. to maintain control of the third stage.

To reduce the satellite's spin rate to the desired 10.9 r.p.m., a timer triggers two weights attached to cables wrapped around the outside of the satellite. As the weights uncoil, they reduce the spin to the proper rate and then automatically drop away from the spacecraft.

The interaction between the earth's magnetic field and magnetic material in the spacecraft causes a drag effect which reduces the spin rate, making the satellite unstable. To prevent this, the satellite has two types of spin control systems - a magnetic coil inside the spacecraft and small, solid-propellant rockets for backup.

The magnetic coil, made of aluminum, is 30 inches long and is tightly wrapped inside a rectangular spool in the spacecraft. The satellite's spin rate can be kept nearly constant by sending small charges of electric current through the coil.

As a backup method of maintaining the spin rate, five pairs of small solid-propellant rockets mounted on the rim of the spacecraft can be fired upon command from a ground station. Each rocket motor develops an impulse of approximately 1.4 pounds per second. When fired in pairs, these rockets can increase the spin rate by about three r.p.m.

Attitude Sensors

Two infrared horizon sensors arranged in a V configuration determine the satellite's attitude in space. The plane of the V contains the spin axis, and the bisector of the angle between the optical axes is normal to the spin vector.

If the spin axis of the satellite is normal to an earth radius, the outputs of the sensors are identical. If a yaw error exists at one point in orbit, there will be an equal roll error 90 degrees later in orbit because of the inertial rigidity of the spin vector. Roll error is detectable as an inequality in the pulse durations of the two sensors. Because accuracy is determined by the resolution and reliability of each of the data points, at least 10 minutes of roll error data will be required in a given pass. The roll error data will be used by the satellite control center to correct attitude and spin rate errors.

Power Supply

The power supply delivers up to 2.2 amperes and consists of solar cells, storage batteries, voltage regulators, and protective circuits.

Solar energy is converted to electricity by 9,100 N on P solar cells, 1 cm. by 2 cm., attached to the top and sides of the spacecraft cover assembly. The cells are arranged in shingles of five series-connected cells. Each cell has a bonded coat of fused silica to improve thermal emissivity, a vacuum-deposited antireflective coating, and a 6-mm. shield to prevent radiation damage.

During the daylight orbits, power from the solar array is fed directly to spacecraft subsystems. Current not used immediately charges 63 nickel-cadmium storage batteries which have a capacity of 295 watt-hours. The batteries, connected in three parallel strings of 21 cells, supply spacecraft power during the nighttime.

Diodes in the solar cells prevent the storage batteries from discharging into the solar cells during orbital night.

DELTA LAUNCH VEHICLE

Delta is a launch vehicle program of NASA's Office of Space Science and Applications. Project management is the responsibility of the Goddard Space Flight Center. Launch agency for Goddard is the Kennedy Space Center's Unmanned Launch Operations. Prime contractor is the Douglas Aircraft Co.

Delta Statistics

The three-stage Delta for the ESSA B launching has the following characteristics:

Height: 92 feet (includes shroud)

Maximum Diameter: 8 feet (without attached solids)

Liftoff Weight: about 75 tons

Liftoff Thrust: 333,500 pounds (including strap-on solids)

First Stage (liquid only): Modified Air Force Thor, produced by Douglas Aircraft Co., engines produced by Rocketdyne Division or North American Aviation.

Diameter: 8 feet

Height: 51 feet

Propellants: RP-1 kerosene is used as the fuel, and liquid oxygen (LOX) is utilized as the oxidizer.

Thrust: 172,000 pounds

Burning Time: 2 minutes and 31 seconds

Weight: Approximately 53 tons

Strap-on Solids: Three solid propellant Sergeant rockets produced by the Thiokol Chemical Corp.

Diameter: 31 inches

Height: 19.8 feet

Weight: 27,510 pounds (9,170 each)

Thrust: 161,550 pounds (53,850 each)

Burning Time: 43 seconds

Second Stage: Produced by the Douglas Aircraft Co., utilizing the Aerojet General Corp., AJ10-118A propulsion system; major contractors for the autopilot include Minneapolis-Honeywell, Inc., Texas Instruments, Inc., and Electrosolids Corp.

Propellants: Liquid--Unsymmetrical Dimethyl Hydrazine (UDMH) for the fuel, and Inhibited Red Fuming Nitric Acid (IRFNA) for the oxidizer.

Diameter: 4.7 feet (compared to 2.7 feet for the earlier Deltas)

Height: 16 feet

Weight: 6½ tons (compared to 2½ tons for the earlier Deltas)

Thrust: 7,700 pounds

Burning Time: Approximately 400 seconds (compared to 150 seconds for the earlier Deltas)

Guidance: Western Electric Co.

Third Stage: Allegany Ballistics Laboratory X-258 motor.

Propellants: Solids

Height: 5½ feet

Diameter: 1½ feet

Weight: 570 pounds

Thrust: 5,760 pounds

Burning Time: 23 seconds

PROJECT MANAGEMENT

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NATIONAL ENVIRONMENTAL SATELLITE CENTER, ESSA

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Michael L. Garbacz, TIROS/TOS Program Manager

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NASA, GODDARD SPACE FLIGHT CENTER (TOS and Delta Project management)

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Robert H. Gray, Assistant Director of Unmanned Launch Operations

RADIO CORPORATION OF AMERICA, Astro-Electronics Division, Hightstown, N. J.
(Spacecraft contractor)

Abraham Schnapf, TOS Project Manager

DOUGLAS AIRCRAFT COMPANY, Santa Monica, Calif. (Launch vehicle contractor)

Jack Kline, Director, Delta Programs

Marcus F. Cooper, Director, Florida Test Center

WEATHER SATELLITE RECORD

<u>Satellite</u>	<u>Launch Date</u>	<u>Lifetime</u>	<u>Inclination</u>	<u>Meteorologically Useable Pictures</u>
TIROS I	Apr. 1, 1960	2½ mos.	48 degrees	19,389
TIROS II	Nov. 23, 1960	10 mos.	48 degrees	25,574
TIROS III	July 12, 1961	4½ mos.	48 degrees	24,000
TIROS IV	Feb. 8, 1962	4½ mos.	48 degrees	23,370
TIROS V	June 19, 1962	10½ mos.	58 degrees	48,547
TIROS VI	Sept. 18, 1962	13 mos.	58 degrees	59,830
TIROS VII	June 19, 1963	Still Operating	58 degrees	111,015*
TIROS VIII	Dec. 21, 1963	Still Operating	58 degrees	88,662*
NIMBUS I	Aug. 28, 1964	26 days	near polar 82 degrees	27,000
TIROS IX	Jan. 22, 1965	Still Operating	near polar 83 degrees	64,459*
TIROS X	July 2, 1965	Still Operating	near polar 81 degrees	55,387 *
ESSA I	Feb. 3, 1966	Still Operating	near polar 82 degrees	5,407*
Total Pictures: 552,640*				

* As of February 15, 1966

These satellites have tracked almost every tropical storm and hurricane since 1960, enabling the Weather Bureau to issue more than 2,500 storm bulletins. The thousands of pictures have been used to construct more than 20,000 of the nephanalyses (cloud maps) used daily for analysis of world weather maps.